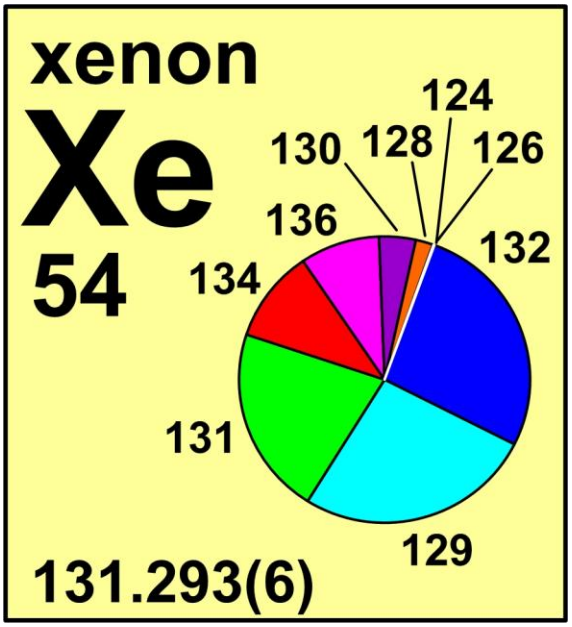
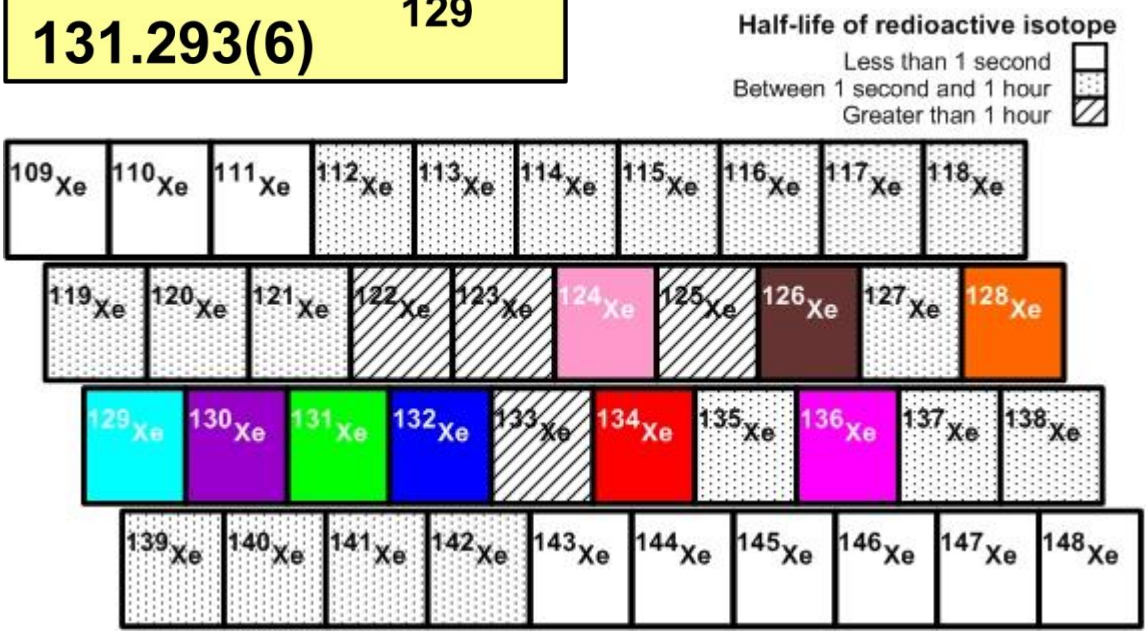
## xenon




| Stable isotope | Atomic mass* | Mole fraction |
|---|---|---|
| $^{124}$Xe | 123.905 893 | 0.000 953 |
| $^{126}$Xe | 125.904 274 | 0.000 890 |
| $^{128}$Xe | 127.903 5313 | 0.019 10 |
| $^{129}$Xe | 128.904 7794 | 0.2640 |
| $^{130}$Xe | 129.903 508 | 0.040 71 |
| $^{131}$Xe | 130.905 0824 | 0.212 33 |
| $^{132}$Xe | 131.904 1535 | 0.269 087 |
| $^{134}$Xe | 133.905 3945 | 0.104 36 |
| $^{136}$Xe | 135.907 219 | 0.088 58 |

* Atomic mass given in unified atomic mass units, u.




### Important applications of stable and/or radioactive isotopes

Isotopes in geochronology

1) The many stable isotopes of Xe hold many different clues about the formation of the elements, solar system history, and Earth processes. One of the more interesting applications is as a detector of "extinct" radionuclides. Some $^{129}$Xe is radiogenic, having been produced by radioactive decay of $^{129}$I (half-life = 1.6 x $10^7$ a). Because the half-life of $^{129}$I is much smaller than the age of the Earth, primordial $^{129}$I (i.e., that which was present at the beginning of Earth history) is essentially gone, having decayed to $^{129}$Xe over geologic time. This means that radiogenic $^{129}$Xe could be a marker of the former existence of the "extinct" isotope $^{129}$I.

2) Although much of this radiogenic $^{129}$Xe has been dissipated or diluted with much larger amounts of other planetary Xe in the Earth and its atmosphere, it can still be found in some relatively isolated occurrences. Anomalously high ratios of $^{129}$Xe to other Xe isotopes in some natural gases and volcanic rocks have been interpreted as decay products of "extinct" primordial $^{129}$I. This would imply that parts of the Earth escaped being mixed or degassed in the time since very early in Earth history, a short time after condensation from the solar disk.
3) Moreover, because primordial $^{129}$I was produced largely in supernovae, detection of radiogenic $^{129}$Xe in meteorites and terrestrial samples also implies that the time elapsed between $^{129}$I supernova nucleosynthesis and planetary condensation was short compared to the subsequent history of the solar system.
4) The many isotopes and reaction mechanism of Xe have contributed numerous insights into Earth processes, through the study of "xenology".

Isotopes in forensics

1) Radiogenic Xe isotopes are produced by nuclear reactions in atomic bombs and nuclear reactors. For example $^{131}$Xe, $^{133}$Xe, and $^{135}$Xe are some of the fission products of $^{235}$U and $^{239}$Pu.
2) Measurements of Xe isotopes (e.g., in the atmosphere or the subsurface) can be used to identify contamination from these sources, for example, to detect faults in nuclear reactors or to monitor compliance with nuclear test bans (Figure 1).

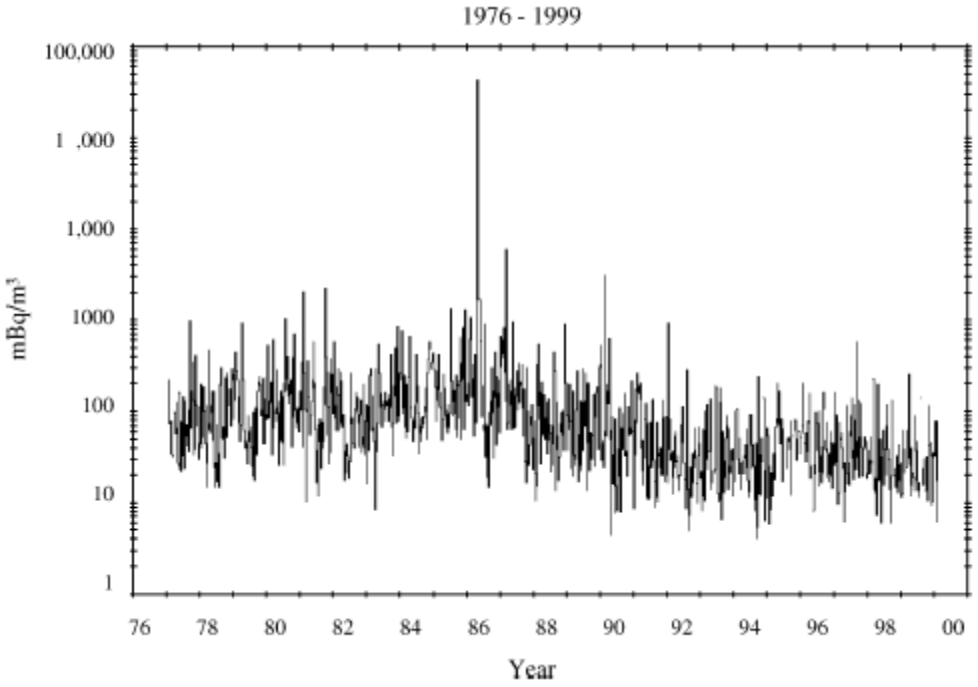



Figure 1: Monitoring of $^{133}$Xe in air Freiburg, Germany from 1986 to 1999. The record indicates persistent low levels of anthropogenic $^{133}$Xe generally attributable to normal acceptable releases from nuclear power plants, with variability related in part to multiple sources and changing wind patterns. A major spike occurred in 1986 during the Chernobyl reactor accident in Russia. The half life of $^{133}$Xe (5.2 d) is long enough for it to escape from its source and be distributed in air near the source, but short enough that the long-term background levels are very low. Records such as this also could detect undocumented nuclear explosions.

Isotopes in medicine

1) Xe isotopes are used in various ways to investigate the movement of inhaled gases in the lungs and other parts of the body. Inhaled radioactive isotopes $^{127}$Xe and $^{133}$Xe can be tracked throughout the body by externally monitoring their decay products, to assess the efficiency of uptake and transport of oxygen by the blood.
2) Hyperpolarized $^{129}$Xe is used in magnetic resonance imaging of gas flows in the lungs.

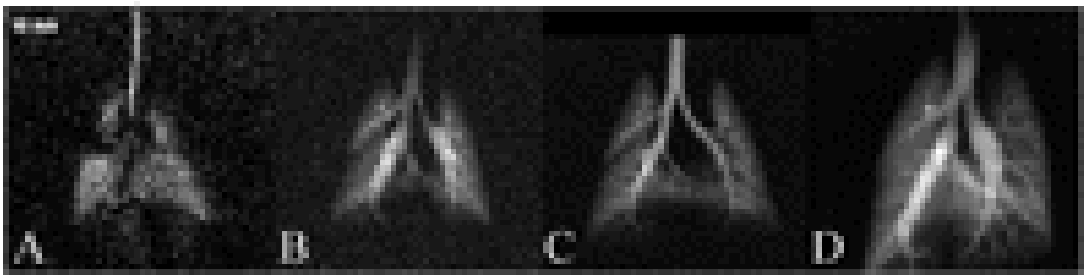



Figure 2: Xenon ventilation imaging has progressed greatly since first being used in 1998. One of the first $^{129}$Xe images is (A) and by improving polarization, gas delivery technology, and MR acquisition strategies the image quality has improved. The current standard $^{129}$Xe image is (D) and further improvement in image quality is expected through continued progress in improving polarization, gas delivery technology, and MR acquisition strategies.

3) $^{124}$Xe is used in the production of radioisotopes $^{123}$I and $^{125}$I, which are used in diagnostic procedures and cancer treatment, respectively.